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PATENT TRADEMARK OFFICE

164.1001.01

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Title of the Invention

Robust Topology Wireless Communication Using Broadband Access Points

Background of the Invention

*1. Field of the Invention*

This invention relates to robust topology wireless communication using access points.

Wireless communication between a sender and a receiver includes sending information using a wireless communication link, in which the sender modulates information onto a wireless communication channel (such as a frequency band reserved for wireless communication between the sender and the receiver), and the receiver demodulates that information from the wireless communication channel, so as to recover the original information.

1           One problem with known systems is that wireless communication channels are  
2 subject to several communication problems that make them relatively unreliable in comparison to  
3 wireline communication channels. Among these communication problems are interference, ran-  
4 dom or pseudo random noise, and multi-path effects. For a first example, a wireless communi-  
5 cation channel can be subject to information sent on other wireless communication channels  
6 having nearby frequencies or other similar modulation formats. For a second example, a wireless  
7 communication channel can be subject to random or pseudo random noise, such as might be gen-  
8 erated by ambient noise sources. For a third example, the information sent on a wireless com-  
9 munication channel can be reflected or refracted so as to arrive at its destination at more than one  
10 time and with varying degrees of attenuation. Of course, a most serious communication problem  
11 involves complete lack of communication between sender and receiver due to an obstruction on  
12 the line of sight path between sender and receiver.

13  
14           One known method to account for these communication problems is to attempt to  
15 determine the nature of the communication problems likely to plague the wireless communica-  
16 tion channel between a selected sender and receiver, and to attempt to reverse the effects of these  
17 communication problems. For a first example, the effects of interference and noise can be allevi-  
18 ated in part by error correcting codes and other known techniques of communication using noisy  
19 channels. For a second example, multi-path effects can be alleviated in part by attempting to de-  
20 termine an impulse response of the wireless communication link, and to invert that impulse re-  
21 sponse at either the sender or the receiver, so as to cancel those multi-path effects in the signal  
22 eventually presented to the receiver.

1           Although these known methods generally achieve the result of improving com-  
2   munication on wireless communication links, they are subject to several drawbacks. First, these  
3   known methods are severely limited in their ability to provide wireless communication to loca-  
4   tions not reachable by point to point links, such as locations behind obstructions like buildings or  
5   mountains, or locations at nodes in an interference or reflection pattern at the selected communi-  
6   cation frequency. Second, these known methods are severely degraded with increases in interfer-  
7   ence or noise (of any kind), and can at best achieve communication capability associated with a  
8   noiseless communication link. Moreover, none of these known methods achieve the capability of  
9   solving the problem of complete lack of communication between sender and receiver due to an  
10   obstruction on the line of sight path between sender and receiver.

11  
12           Accordingly, it would be advantageous to provide a technique for wireless com-  
13   munication, such as for use in a wireless communication system, that is not subject to drawbacks  
14   of the known art.

### 15 16                           Summary of the Invention

17  
18           The invention provides a method and system for robust topology wireless com-  
19   munication using access points. In a preferred embodiment, a wireless communication system  
20   includes a communication cell having a base station controller and at least one set of customer  
21   premises equipment. The customer premises equipment is disposed within a sector of the cell,  
22   and communication between the base station controller and the customer premises equipment is  
23   controlled by the base station controller is so as to prevent interference between multiple sets of  
24   customer premises equipment. When customer premises equipment is subject to relatively larger

1 amounts of interference or noise, one or more access points are disposed within the sector, so as  
2 to propagate or route communication between the base station controller and one or more sets of  
3 customer premises equipment. In aspects of the invention described herein, the access points  
4 may range in complexity from simple reflectors, to repeaters, to routing devices operative within  
5 the cell.

6  
7 The invention provides an enabling technology for a wide variety of applications  
8 for wireless communication, so as to obtain substantial advantages and capabilities that are novel  
9 and non-obvious in view of the known art. Examples described below primarily relate to cellular  
10 wireless communication systems, but the invention is broadly applicable to many different types  
11 of wireless and other communication systems.

### 12 Brief Description of the Drawings

13  
14  
15 Figure 1 shows a first block diagram of a system for wireless communication us-  
16 ing robust topology.

17  
18 Figure 2 shows a second block diagram of a system for wireless communication  
19 using robust topology.

20  
21 Figure 3 shows a third block diagram of a system for wireless communication us-  
22 ing robust topology.

Figure 4 shows a fourth block diagram of a system for wireless communication using robust topology.

Figure 5 shows a fifth block diagram of a system for wireless communication using robust topology.

#### Detailed Description of the Preferred Embodiment

In the following description, a preferred embodiment of the invention is described with regard to preferred process steps and data structures. Embodiments of the invention can be implemented using general-purpose processors or special purpose processors operating under program control, or other circuits, adapted to particular process steps and data structures described herein. Implementation of the process steps and data structures described herein would not require undue experimentation or further invention.

#### *Related Applications*

Inventions described herein can be used in conjunction with inventions described in the following documents.

- U.S. Patent Application Serial No. 09/475,642, Express Mail Mailing No. EL524 780 018 US, filed December 30, 1999, in the name of of Varma, Subir, Ngo, Khuong, Fuentes, Jean, Truong, Paul, and Majidi-Ahy, Reza, attorney docket number 164.1002.01, titled "Adaptive Link Layer for Point to Multipoint Communication System."

- 1 • U.S. Patent Application Serial No. 09/475,716, Express Mail Mailing No. EL 524 780  
2 021 US, filed December 30, 1999, in the name of Majidi-Ahy, Reza, Hakim, Joseph, and  
3 Varma, Subir, attorney docket number 164.1003.01, titled "Integrated Self-Optimizing  
4 Multi-Parameter and Multi-Variable Point to MultiPoint Communication System."

5  
6 Each of these documents is hereby incorporated by reference as if fully set forth  
7 herein. These documents are sometimes collectively referred to herein as the "Incorporated Dis-  
8 closures."

9  
10 *Lexicography*

11  
12 The following terms refer or relate to aspects of the invention as described below.  
13 The descriptions of general meanings of these terms are not intended to be limiting, only illustrative.  
14

- 15  
16 • **access point** — in general, a device for performing message forwarding (either passively  
17 or actively) within a wireless communication cell. There is no particular requirement that  
18 an access point must be a single device; in alternative embodiments, the access points can  
19 each include a portion of a single device, a combination of multiple devices, or some hybrid thereof. Access points are sometimes referred to herein as "broadband" access  
20 points, to indicate their generic ability to handle broadband communication instead of, or  
21 in addition to, narrowband communication.  
22  
23

- 1 • **base station controller** — in general, a device for performing coordination and control  
2 for a wireless communication cell. There is no particular requirement that the base sta-  
3 tion controller must be a single device; in alternative embodiments, the base station con-  
4 troller can include a portion of a single device, a combination of multiple devices, or  
5 some hybrid thereof.  
6
- 7 • **cell** — in general, a region associated with a base station controller in which customer  
8 premises equipment communicate with the base station controller and in which the base  
9 station controller exercises control over communication parameters. Although in a pre-  
10 ferred embodiment, cells are each contiguous and compact, there is no particular re-  
11 quirement for either property; cells may include non-contiguous sub-regions and are not  
12 necessarily compact.  
13
- 14 • **communication link** — in general, an element for sending information from a sender to a  
15 recipient. Although in a preferred embodiment the communication links referred to are  
16 generally wireless line of sight point-to-point communication links, there is no particular  
17 requirement that they are so restricted.  
18
- 19 • **customer premises equipment** — in general, a device for performing communication  
20 processes and tasks at a customer location, and operating in conjunction with the base  
21 station controller within a wireless communication cell. There is no particular require-  
22 ment that the customer premises equipment must be a single device; in alternative em-  
23 bodiments, the customer premises equipment can include a portion of a single device, a  
24 combination of multiple devices, or some hybrid thereof.

- 1
- 2 • **MAC parameters** — in general, with reference to a wireless communication link, a set
- 3 of characteristics or parameters relating to media access control of a communication link.
- 4 For example, MAC parameters can include (a) a number of payload data bytes assigned
- 5 per message, (b) a frequency of acknowledgement messages and a number of message
- 6 retransmission attempts, (c) a fraction of the communication link allocated to downstream
- 7 versus upstream communication, and the like.
- 8
- 9 • **physical parameters** — in general, with reference to a wireless communication link, a
- 10 set of characteristics or parameters relating to physical transmission of information on a
- 11 communication link. For example, physical characteristics can include (a) a symbol
- 12 transmission rate, (b) a number of payload data bits assigned per symbol, (c) a number of
- 13 error detection or correction bits assigned per symbol, and the like.
- 14
- 15 • **propagate or route** — in general, to forward a message from a sender toward a destina-
- 16 tion using an intermediate point, such as an intermediate reflector, repeater, or routing or
- 17 switching element
- 18
- 19 • **sector** — in general, a portion of a cell that is not the entire cell. For example, a cell can
- 20 be divided into multiple sectors in response to an angle of direction or a distance from the
- 21 base station controller. There is no particular requirement that sectors must be disjoint;
- 22 they may be overlapping.
- 23



- 1 • **wireless communication system** — in general, a communication system including at  
2 least one communication link that uses wireless communication techniques.  
3
- 4 • **wireless transport layer** — in general, a set of protocols and protocol parameters for  
5 sending and receiving information using wireless transport. In a preferred embodiment,  
6 the wireless transport layer is part of a multilayer systems architecture, in which the  
7 wireless transport layer is built using a physical transport layer, and the wireless transport  
8 layer is used by a logical transport layer such as IP.  
9

10 As noted above, these descriptions of general meanings of these terms are not in-  
11 tended to be limiting, only illustrative. Other and further applications of the invention, including  
12 extensions of these terms and concepts, would be clear to those of ordinary skill in the art after  
13 perusing this application. These other and further applications are part of the scope and spirit of  
14 the invention, and would be clear to those of ordinary skill in the art, without further invention or  
15 undue experimentation.  
16

### 17 *System Context*

18

19 A system using point to multipoint wireless communication in a wireless commu-  
20 nication system operates as part of a system in which devices coupled to a network (such as a  
21 computer network) send messages, route and switch messages, and receive messages. In a pre-  
22 ferred embodiment, devices coupled to (and integrated with) the network send, route, and receive  
23 these messages as sequences of packets, each of which has a header including delivery informa-  
24 tion and a payload including data. In a preferred embodiment, packet format conforms to the

OSI model, in which relatively higher-level protocols such as an application protocol (layer 5, such as FTP), use relatively lower-level protocols such as a transport protocol (layer 4, such as TCP), which uses a network protocol (layer 3, such as IP), which uses a media access control (MAC) protocol (layer 2), which uses a physical transport technique (layer 1). In a preferred embodiment, packet format conforms to the OSI model, in which relatively lower-level protocols use higher-level protocols to recover from communication difficulties.

The system for wireless communication using robust topology is described herein with regard to layer 1 and layer 2, particularly as it applies to interactions between layer 1 and layer 2 and between those layers and layer 3. However, concepts and techniques of the invention are also applicable to other layers of the OSI model. Adapting those concepts and techniques to such other layers would not require undue experimentation or further invention, and is within the scope and spirit of the invention.

### *System Elements*

Figure 1 shows a first block diagram of a system for wireless communication using robust topology.

A system 100 includes a wireless communication cell 110, a base station controller 120, and one or more sets of customer premises equipment 130. The system 100 also includes a set of more than one sector 111 within the cell 110, a set of zero or more access points 140 within each sector 111, and a set of packets 150 sent among the elements of the system 100.

1           The wireless communication cell 110 includes a generally hexagon-shaped region  
2 of local surface area, such as might be found in a metropolitan region. Use of generally hexagon-  
3 shaped regions is known in the art of wireless communication because they are able to tile a local  
4 region with substantially no gaps. However, although in a preferred embodiment the wireless  
5 communication cell 110 includes a generally hexagon-shaped region, there is no particular re-  
6 quirement for using that particular shape; in alternative embodiments it may be useful to provide  
7 another shape or tiling of the local surface area.

8  
9           The base station controller 120 includes a processor, program and data memory,  
10 mass storage, and one or more antennas for sending or receiving information using wireless  
11 communication techniques.

12  
13           Similar to the base station controller 120, each set of customer premises equip-  
14 ment 130 includes a processor, program and data memory, mass storage, and one or more anten-  
15 nas for sending or receiving information using wireless communication techniques.

16  
17           Communication among devices within the wireless communication cell 110 is  
18 conducted on one-to-one basis between each set of customer premises equipment 130 and the  
19 base station controller 120. Thus, the base station controller 120 communicates with each set of  
20 customer premises equipment 130, and each set of customer premises equipment 130 communi-  
21 cates with the base station controller 120. Customer premises equipment 130 do not communi-  
22 cate directly with other customer premises equipment 130.

1           Communication between the base station controller 120 and each set of customer  
2 premises equipment 130 is conducted using a time division duplex technique, in which time du-  
3 ration is are divided into individual frames, each one of which includes a “downstream” portion  
4 and an “upstream” portion. Unlike existing protocols in which transmissions are controlled by  
5 the transmitting side, the base station controller 120 controls transmissions for both upstream and  
6 downstream directions, without specific requests from the customer premises equipment 130.

7  
8           During the downstream portion of each frame, the base station controller 120  
9 transmits, thus sending information to one or more sets of customer premises equipment 130.  
10 During the upstream portion of each frame, the base station controller automatically allocates  
11 slots for upstream re-transmission. This occurs in the absence of an explicit request for a slot  
12 from the customer premises equipment 130. Particular aspects of each frame are described in the  
13 Incorporated Disclosures. Time division duplex techniques are known in the art of wireless  
14 communication.

#### 15 16 *Access Points 1*

17  
18           In a first block diagram shown in figure 1, each access point 140 includes a re-  
19 flector 141. Reflectors are known in the art of wireless communication.

20  
21           Each packet 150 sent from the base station controller 120 to the customer prem-  
22 ises equipment 130 can be sent line-of-sight to an access point 140, which can include a reflector  
23 141, rather than line-of-sight from the base station controller 120 to the customer premises  
24 equipment 130. The reflector 141 at the access point 140 causes the electromagnetic signal car-

1 rying the packet 150 to be reflected from a first outbound path 151 to a second outbound path  
2 152, so that the packet 150 reaches the customer premises equipment 130 in better form than us-  
3 ing a line-of-sight path between the base station controller 120 to the customer premises equip-  
4 ment 130.

5  
6 Similarly, each packet 150 sent from the customer premises equipment 130 to the  
7 base station controller 120 can be sent line-of-sight to an access point 140, which can include a  
8 reflector 141, rather than line-of-sight from the customer premises equipment 130 to the base  
9 station controller 120. The reflector 141 at the access point 140 causes the electromagnetic sig-  
10 nal carrying the packet 150 to be reflected from a first inbound path 153 to a second inbound path  
11 154, so that the packet 150 reaches the base station controller 120 in better form than using a  
12 line-of-sight path between the customer premises equipment 130 to the base station controller  
13 120.

#### 14 15 *Access Points 2*

16  
17 Figure 2 shows a second block diagram of a system for wireless communication  
18 using robust topology.

19  
20 In a second block diagram shown in figure 2, each access point 140 includes a re-  
21 peater 142. Repeaters are known in the art of wireless communication. Each repeater 142 in-  
22 cludes a reconditioning element 143, such as including amplifiers and noise-removal circuits.

1           Similar to access points 140 including reflectors 141, each packet 150 sent from  
2 the base station controller 120 to the customer premises equipment 130 can be sent line-of-sight  
3 to an access point 140, rather than line-of-sight from the base station controller 120 to the cus-  
4 tomer premises equipment 130. At the access point 140, the packet 150 is received, recondi-  
5 tioned (for example, noise is reduced and the signal is re-amplified), and resent from the access  
6 point 140 to the destination customer premises equipment 130, so that the packet 150 reaches the  
7 customer premises equipment 130 in better form than using a non-reconditioned path between  
8 the base station controller 120 and the customer premises equipment 130.

9  
10           Similarly, access points 140 using repeaters 142 can also be used for sending  
11 packets from the customer premises equipment 130 to the base station controller 120.

12  
13           Access points 140 can include both reflectors 141 and repeaters 142, and can in-  
14 clude combinations thereof, so that a packet 150 can sent line-of-sight to an access point 140,  
15 reconditioned at that access point 140 using a repeater 142 or variant thereof, and resent line-of-  
16 sight to its destination (either the base station controller 120 or the customer premises equipment  
17 130).

### 18 19 *Access Points 3*

20  
21           Figure 3 shows a third block diagram of a system for wireless communication us-  
22 ing robust topology.

1 In a third block diagram shown in figure 3, each access point 140 includes a rout-  
2 ing or switching device 143 operative within a sector 111 or within a cell 110. Routing or  
3 switching devices 143 are known in the art of communication networks.

4  
5 Similar to access points 140 including reflectors 141, each packet 150 sent from  
6 the base station controller 120 to the customer premises equipment 130 can be sent line-of-sight  
7 to an access point 140, rather than line-of-sight from the base station controller 120 to the cus-  
8 tomer premises equipment 130. At the access point 140, the packet 150 is received, routed (for  
9 example, the destination customer premises equipment 130 is determined and the packet 150 is  
10 resent line-of-sight to that destination customer premises equipment 130), and resent from the  
11 access point 140 to the destination customer premises equipment 130, so that the packet 150  
12 reaches the customer premises equipment 130 in better form than using a non-routed path be-  
13 tween the base station controller 120 and the customer premises equipment 130.

14  
15 Similarly, access points 140 using routing or switching devices 143 can also be  
16 used for sending packets from the customer premises equipment 130 to the base station controller  
17 120.

18  
19 Access points 140 can include any one of reflectors 141, repeaters 142, and rout-  
20 ing or switching devices 143, and can include combinations thereof, so that a packet 150 can sent  
21 line-of-sight to an access point 140, routed or switched at that access point 140 using a routing or  
22 switching device 143 or variant thereof, reconditioned at that access point 140 using a repeater  
23 142 or variant thereof, and resent line-of-sight to its destination (either the base station controller  
24 120 or the customer premises equipment 130).

Moreover, routing or switching devices 143 can be used to enforce restrictions on communication between the base station controller 120 and the customer premises equipment 130, using either ACL (access control list) restrictions, QoS (quality of service) restrictions, or other restrictions known in the art of communication networks. Those skilled in the art will find, after perusal of this application, that the possibility of enforcing such restrictions is part of the scope and spirit of the invention, and would not require undue experimentation or further invention.

#### *Access Points 4*

Figure 4 shows a fourth block diagram of a system for wireless communication using robust topology.

Similar to the third block diagram shown in figure 3, in a fourth block diagram shown in figure 4, each access point 140 includes a routing or switching devices 143 operative within a sector 111 or within a cell 110.

Similar to access points 140 including routing or switching devices 143 that route or switch packets 150 directly to destination customer premises equipment 130, each packet 150 sent from the base station controller 120 to the customer premises equipment 130 can be sent line-of-sight to an access point 140, rather than line-of-sight from the base station controller 120 to the customer premises equipment 130. At the access point 140, the packet 150 is received, routed (for example, the destination customer premises equipment 130 is determined and the



1 packet 150 is resent line-of-sight to a second access point 140), and resent from the access point  
2 140 to that second access point 140. From the second access point 140, the packet 150 is again  
3 received, routed (for example, the destination customer premises equipment 130 is determined  
4 and the packet 150 is resent line-of-sight to the destination customer premises equipment 130),  
5 so that the packet 150 reaches the customer premises equipment 130 in better form than using a  
6 non-routed path between the base station controller 120 and the customer premises equipment  
7 130.

8  
9 Similarly, access points 140 using routing or switching devices 143 can also be  
10 used for sending packets from the customer premises equipment 130 to the base station controller  
11 120, by way of intermediate access points 140 (whether including routing or switching devices  
12 143 or not).

#### 13 14 *Access Points 5*

15  
16 Figure 5 shows a fifth block diagram of a system for wireless communication us-  
17 ing robust topology.

18  
19 Similar to the third block diagram shown in figure 3, and similar to the fourth  
20 block diagram shown in figure 4, in a fifth block diagram shown in figure 5, each access point  
21 140 includes a routing or switching devices 143 operative within a sector 111 or within a cell  
22 110.

1 Similar to access points 140 described above, those access points 140 including  
2 routing or switching devices 143 can route or switch packets 150 among themselves, so as to  
3 route or switch packets 150 from the base station controller 120 to a set of intermediate access  
4 points 140 to the customer premises equipment 130. Multi-hop routing of packets 150 is known  
5 in the art of communication networks.

6  
7 At each access point 140, the packet 150 is received, routed, and resent from the  
8 access point 140 to a next hop. From the next hop, the process is repeated, until the packet 150 is  
9 sent line-of-sight to the customer premises equipment 130, and thus reaches the customer prem-  
10 ises equipment 130 in better form than using a non-routed path between the base station control-  
11 ler 120 and the customer premises equipment 130.

12  
13 In a preferred embodiment, each access point 140 includes a routing or switching  
14 device 143 capable of performing at least some of the following functions:

- 15
- 16 • **IP routing** — routing or switching devices 143 can route packets 150 using IP layer  
17 routing or switching
  - 18
  - 19 • **MAC routing** — routing or switching devices 143 can route packets 150 using MAC  
20 layer routing or switching
  - 21
  - 22 • **Re-Adaptation** — routing or switching devices 143 can re-adapt packets 150, such as  
23 breaking packets 150 into smaller units and collecting smaller units into larger packets  
24 150

- **Mini-Scheduler** — routing or switching devices 143 can include a scheduling function for determining which packets 150 to give priority to in routing, re-adaptation, and resending

Routing and switching devices 143 can also be configured so as to route or switch only within a single sector 111 within a cell 110, or to route or switch among multiple sectors 111 within a cell 110.

#### *Access Points (Further Generality)*

Those skilled in the art will recognize, after perusal of this application, that the architectures shown in the figures and described herein can be substantially generalized in several ways.

First, the addition of access points 140 within a cell 110 allows the base station controller 120 to add additional capacity for sending and receiving messages in conjunction with customer premises equipment 130. Thus, the set of access points 140 (using reflectors 141, repeaters 142, or routing or switching devices 143) can form a mesh network in which messages are routed between the base station controller 120 and customer premises equipment 130, using the set of access points 140 as a communication sub-network. The communication sub-network is thus simultaneously (1) a distributed network of intermediate nodes in a switching network, and (2) a centralized switching system under control of the base station controller 120. For example, the set of access points 140 each operate independently to perform routing and switching

(possibly including other aspects of routing and switching, such as scheduling, quality of service guarantees, and flow management), while the base station controller 120 controls the PHY and MAC parameters (as shown in the Incorporated Disclosures) of each of the access points 140. The base station controller 120 can control each of the access points 140 separately, or can determine global parameters for use within a cell 110 or sector within a cell 110.

Second, each access point 140 can perform some or all of the functions of the base station controller 120, only limited to a portion of the cell 110. Thus, within a single sector within a single cell 110, the base station controller 120 and the set of access points 140 within that sector can cooperate to control traffic, so as to form a micro-cell within the cell 110. There is no particular requirement that any one micro-cell must be entirely within a single sector; micro-cells can span portions of multiple sectors or even portions of multiple cells 110. This also allows the base station controller 120 and the set of access points 140 to cooperatively maintain a multi-tier cellular architecture, with each micro-cell each controlled by an associated access point 140 and cells 110 including multiple micro-cells controlled by the base station controller 120.

Third, the addition of access points 140 within a cell 110 allows the base station controller 120 to add incremental additional capacity for sending and receiving messages and controlling the flow of messages within the cell 110. This enables the wireless system to grow in incremental steps, rather than large jumps in capacity, so as to create a “pay as you grow” deployable system. There is no particular requirement that the addition of access points 140 within a cell 110 requires the base station controller 120 itself to have additional capacity or functionality.

1 Fourth, there is no particular requirement that communication paths must be line  
2 of sight. Although in a preferred embodiment, most electromagnetic communication is line of  
3 sight, it is also possible for electromagnetic communication to include non line of sight compo-  
4 nents. A first example is differential penetration of barriers at different frequencies, such as  
5 buildings which pose a substantial reflection problem at a first frequency  $f_1$  but do not pose a  
6 substantial reflection problem at a second frequency  $f_2$ . A second example is refraction of elec-  
7 tromagnetic communication at known frequencies so as to obtain a non line of sight path. A  
8 third example is multipath addition resulting in communication between a first peak and a second  
9 peak in a communication standing wave. Those skilled in the art will recognize, after perusal of  
10 this application and the Incorporated Disclosures, that the base station controller 120 can ma-  
11 nipulate parameters for the PHY, MAC and other layers to improve communication with access  
12 points 140 even under non line of sight conditions.

13  
14 Fifth, the addition of access points 140 within a cell 110 presents a new opportu-  
15 nity for the base station controller 120 to control quality of service (QOS) and flow management  
16 within the cell 110. The base station controller 120 can thus control QOS between the base sta-  
17 tion controller 120 and customer premises equipment 130, either by (1) controlling specific PHY  
18 and MAC parameters for direct communication, (2) controlling specific PHY and MAC parame-  
19 ters for indirect communication using access points 140, or (3) selection of the number and loca-  
20 tion of access points 140 for indirect communication with customer premises equipment 130.  
21 Thus, for example, the base station controller 120 can choose, instead of a shortest-path strategy,  
22 a best-QOS strategy for routing messages using access points 140 to customer premises equip-  
23 ment 130.

1 Sixth, those skilled in the art will recognize, after perusal of this application and  
2 the Incorporated Disclosures, that the addition of access points 140 within a cell 110 makes it  
3 easier to deploy the wireless communication system. The base station controller 120 can be lo-  
4 cated in many additional locations, as can customer premises equipment 130. Moreover, since  
5 the base station controller 120 controls the PHY, MAC and other parameters, it is easier to de-  
6 ploy the wireless communication system and obtain acceptable communication between the base  
7 station controller 120 and customer premises equipment 130 using access points 140.

8  
9 Sixth, those skilled in the art will recognize, after perusal of this application and  
10 the Incorporated Disclosures, that the addition of access points 140 within a cell 110 makes it  
11 easier to use the wireless communication system in conjunction with requirements for QOS and  
12 flow management. Since the base station controller 120 controls the PHY, MAC and other pa-  
13 rameters, it is easier to manage the wireless communication system for QOS and flow manage-  
14 ment and obtain acceptable communication between the base station controller 120 and customer  
15 premises equipment 130 using access points 140.

16  
17 *Generality of the Invention*

18  
19 The invention has general applicability to various fields of use, not necessarily  
20 related to the services described above. For example, these fields of use can include one or more  
21 of, or some combination of, the following:

- 22  
23 • The invention is applicable to other forms of wireless communication, such as code divi-  
24 sion multiple access (CDMA, also known as spread spectrum communication), frequency

1 division multiple access (FDMA), space division multiple access (SDMA), time division  
2 multiple access (TDMA), and combinations thereof;

3  
4 • The invention is applicable to wireline (that is, non-wireless) communication, in which  
5 now can be achieved from dynamically adjusting communication parameters, such as  
6 physical parameters or MAC parameters. For example, the invention can be generalized  
7 to wireline communication using modems in which equalization parameters are to be dy-  
8 namically adjusted.

9  
10 • The invention is applicable to other wireless communication systems, such as satellite  
11 communication systems and (microwave tower or other) point to point transmission sys-  
12 tems.

13  
14 • The invention is applicable to both fixed wireless communication systems, in which cus-  
15 tomer premises equipment do not move relative to the base station controller 120, and to  
16 mobile wireless communication systems, and which customer premises equipment move  
17 substantially relative to the base station controller 120.

18  
19 Other and further applications of the invention in its most general form, will be  
20 clear to those skilled in the art after perusal of this application, and are within the scope and spirit  
21 of the invention.

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